

Mark Scheme (Results)

Summer 2013

International GCSE  
Chemistry (4CH0) Paper 1CR

Science Double Award (4SC0)  
Paper 1CR

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Summer 2013

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| Question number | Answer                                                                                                                                                    | Accept | Reject       | Marks    |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------------|----------|
| 1 (a)           | can <u>easily/quickly</u> identify each gas<br>OR<br><u>less likely</u> to make a mistake in identification<br><br><b>IGNORE</b> just to identify the gas |        |              | 1        |
| (b) (i)         | argon/Ar <u>and</u> helium/He                                                                                                                             |        |              | 1        |
| (ii)            | oxygen/O <sub>2</sub><br><b>IGNORE</b> O                                                                                                                  |        |              | 1        |
| (iii)           | air/it is a mixture (of gases)<br>OR<br>air/it is not a single substance<br><b>IGNORE</b> mixture of elements                                             |        |              | 1        |
| (iv)            | not flammable/not explosive/does not burn                                                                                                                 |        |              | 1        |
| (c) (i)         | hydrogen/H <sub>2</sub><br><b>IGNORE</b> H                                                                                                                | air    |              | 1        |
| (ii)            | carbon dioxide/CO <sub>2</sub>                                                                                                                            |        |              | 1        |
| (iii)           | carbon dioxide/CO <sub>2</sub>                                                                                                                            |        |              | 1        |
|                 |                                                                                                                                                           |        | <b>Total</b> | <b>8</b> |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                  | Accept                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Reject                                               | Marks               |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|---------------------|
| 2 (a)           | D                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                      | 1                   |
| (b)             | <p><b>M1</b> before heating – colourless (solution/liquid)<br/> <b>IGNORE</b> clear/transparent/looks like water</p> <p><b>M2</b> after heating – milky/chalky/cloudy/white (precipitate)/turbid</p> <p><b>IGNORE</b> references to goes clear OWTTE</p>                                                                                                                | no colour                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | white solution/liquid<br>any colour other than white | 1<br><br>1          |
| (c)             | <p><b>M1</b> (sulfur dioxide/it) dissolves in/reacts with (rain) water</p> <p><b>M2</b> to form an acidic solution/an acid/sulfurous acid /acid rain<br/> <b>IGNORE</b> references to any other products whether correct or not</p> <p><b>M3</b> which reacts with/corrodes the marble/calcium carbonate</p> <p><b>IGNORE</b> erodes / weathers / melts / eats into</p> | <p><math>\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3</math><br/> OR<br/> <math>\text{SO}_2 + \text{H}_2\text{O} + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{SO}_4</math><br/> for both <b>M1</b> and <b>M2</b></p> <p>sulfuric acid</p> <p><u>chemical</u><br/> weathering<br/> dissolves<br/> correct equation for reaction with either sulfurous or sulfuric acid</p> <p><math>\text{SO}_2</math> reacts with marble for <b>M3</b> only</p> |                                                      | 1<br><br>1<br><br>1 |
|                 |                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Total</b>                                         | <b>6</b>            |

| Question number | Answer                                                                   | Accept            | Reject                                          | Marks |
|-----------------|--------------------------------------------------------------------------|-------------------|-------------------------------------------------|-------|
| 3 (a)           |                                                                          |                   |                                                 | 1     |
|                 |                                                                          |                   |                                                 |       |
|                 |                                                                          |                   |                                                 |       |
|                 |                                                                          |                   |                                                 |       |
|                 |                                                                          |                   |                                                 |       |
|                 |                                                                          |                   |                                                 |       |
| (b)             | M1 (it forms) barium chloride/BaCl <sub>2</sub> /a soluble (barium) salt | by neutralisation | any suggestion that barium chloride is reacting | 1     |
|                 | M2 by reaction/with hydrochloric acid/stomach acid                       |                   |                                                 | 1     |
| (c)             | barium sulfate/BaSO <sub>4</sub>                                         |                   |                                                 | 1     |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                             | Accept                                                                                                                                                                                                                                                                     | Reject | Marks                      |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------------------------|
| 3 (d)           | <p><b>M1</b> barium sulfate is formed</p> <p><b>M2</b> which is not poisonous/not toxic/harmless<br/><b>IGNORE</b> references to magnesium hydroxide not poisonous</p> <p><b>M2</b> dep on <b>M1</b></p> <p><b>M3</b> barium hydroxide + magnesium sulfate → barium sulfate + magnesium hydroxide</p> <p>OR</p> <p>barium ions + sulfate ions → barium sulfate</p> | <p>'products', provided shown correctly in word equation</p> <p>is insoluble</p> <p><math>\text{Ba(OH)}_2 + \text{MgSO}_4 \rightarrow \text{BaSO}_4 + \text{Mg(OH)}_2</math></p> <p>OR</p> <p><math>\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4</math></p> |        | <p>1</p> <p>1</p> <p>1</p> |
| (e) (i)         | <p><b>M1</b> water – (reacts) <u>very/extremely</u> quickly/more quickly <u>than strontium</u>/quickest<br/><b>IGNORE</b> rapidly/vigorously</p> <p><b>M2</b> air – (reacts) <u>very/extremely</u> quickly/more quickly <u>than strontium</u>/quickest<br/>(without heating)<br/><b>IGNORE</b> rapidly/vigorously</p>                                              | <p>explosively/violently</p> <p>explosively/violently</p>                                                                                                                                                                                                                  |        | <p>1</p> <p>1</p> <p>1</p> |
| (ii)            | <p>in/under any one of the following:<br/>(paraffin/mineral) oil/petroleum (oil)/(liquid) paraffin</p>                                                                                                                                                                                                                                                             | <p>in a vacuum</p>                                                                                                                                                                                                                                                         |        | <p>1</p>                   |
| (iii)           | <p><b>IGNORE</b> in an air tight container</p> <p>reactivity <u>increases</u> as atomic number <u>increases</u></p>                                                                                                                                                                                                                                                | <p>reactivity increases with atomic number/down the group OWTTE<br/>reverse argument</p>                                                                                                                                                                                   |        |                            |

|  |  |                      |       |    |
|--|--|----------------------|-------|----|
|  |  | positive correlation |       |    |
|  |  |                      | Total | 12 |

| Question number | Answer                                                                                                                                                                                                                                       | Accept                                                                                                           | Reject                                                                                          | Marks  |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------|
| 4 (a)           | <b>M1</b> (negative electrode) – graphite<br><b>M2</b> (positive electrode) – graphite                                                                                                                                                       | carbon<br>carbon                                                                                                 |                                                                                                 | 2      |
| (b) (i)         | it/aluminium oxide/alumina has a (very) high m.pt<br><b>IGNORE</b> high b.pt/references to strong bonding/bauxite has a high m.pt/lot of energy needed to melt it                                                                            |                                                                                                                  | aluminium has a high melting point                                                              | 1      |
| (ii)            | aluminium oxide/alumina is dissolved in/mixed with (molten/liquid) cryolite<br><b>IGNORE</b> cryolite lowers the m.pt of aluminium oxide/alumina                                                                                             | added to $\text{Na}_3\text{AlF}_6$ for cryolite<br>cryolite is used as the solvent (for aluminium oxide/alumina) | aluminium is dissolved in cryolite                                                              | 1      |
| (c)             | <b>M1</b> reduction<br><b>M2</b> (it/aluminium ions/ $\text{Al}^{3+}$ ) gain of electron(s)<br><b>IGNORE</b> references to loss of oxygen<br><b>M2</b> dep on <b>M1</b>                                                                      | reacts with/combines with<br>decrease in oxidation number/oxidation number changes from +3 to 0                  | redox for <b>M1</b> only<br>Al/aluminium gains electrons                                        | 1<br>1 |
| (d)             | <b>M1</b> oxygen formed/produced (at the positive electrode/anode)<br><b>IGNORE</b> oxygen from the aluminium oxide<br><b>M2</b> reacts with the carbon/the (positive) electrode<br><b>M2</b> not dep on <b>M1</b> , but must mention oxygen | oxygen from the electrolysis<br>anode / graphite                                                                 | any indication that the oxygen is from the air for <b>M1</b> only<br>cathode/negative electrode | 1<br>1 |
| (e)             | Any two from:<br><b>M1</b> malleable<br><b>M2</b> low density                                                                                                                                                                                | easy to shape/easy to bend/easy to extrude bend                                                                  |                                                                                                 | 2      |

|  |                                                                                                                                                              |                            |              |           |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------|-----------|
|  | <b>M3</b> does not react <u>with food/drink(s)</u><br><br><b>IGNORE</b> light(er)/high strength to weight ratio/references to cost/lightweight/does not rust | non-toxic/does not corrode |              |           |
|  |                                                                                                                                                              |                            | <b>Total</b> | <b>10</b> |

| Question number | Answer                                                                                                                                                                                                                                                                    | Accept                                             | Reject                                                                 | Marks               |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|------------------------------------------------------------------------|---------------------|
| 5 (a)           | <b>M1</b> (molecules/compounds/substances) with the same <u>molecular</u> formula/number of each type of atoms<br><br><b>IGNORE</b> chemical formula/same compound<br><br><b>M2</b> (but) different structural formulae/different displayed formulae/different structures | hydrocarbons<br><br><br>atoms arranged differently | elements/atoms<br>general formula/empirical formula for <b>M1</b> only | 1<br><br><br>1      |
| (b)             | D                                                                                                                                                                                                                                                                         |                                                    |                                                                        | 1                   |
| (c) (i)         | <b>M1</b> C <sub>n</sub> H <sub>2n</sub>                                                                                                                                                                                                                                  | letters other than n, e.g. x                       | C <sub>n</sub> +H <sub>2n</sub>                                        | 1                   |
| (ii)            | <b>M1</b> double bond between two left hand end carbon atoms                                                                                                                                                                                                              |                                                    |                                                                        | 1                   |
|                 | <b>M2</b> single bond between each pair of rest of carbon atoms<br><br>Penalise max 1 mark for any extra bond shown                                                                                                                                                       |                                                    |                                                                        | 1                   |
| (d)             | <b>M1</b> addition<br><br><b>M2</b> orange<br><br><b>M3</b> colourless<br><b>IGNORE</b> clear/transparent/looks like water                                                                                                                                                | additional<br><br>yellow/brown                     | red, either on its own or in combination with any other colour         | 1<br><br>1<br><br>1 |
| (e)             | <b>M1</b> saturated – <u>all</u> (carbon to carbon) bonds are single<br><br><u>/contains only</u> (carbon to carbon)                                                                                                                                                      | does not contain any multiple/double bonds         |                                                                        | 1                   |

|  |                                                                                   |  |              |           |
|--|-----------------------------------------------------------------------------------|--|--------------|-----------|
|  | single bonds                                                                      |  |              | 1         |
|  | <b>M2</b> unsaturated - contains (carbon to carbon)<br>double/multiple<br>bond(s) |  |              |           |
|  |                                                                                   |  | <b>Total</b> | <b>11</b> |

| Question number | Answer                                                                                                                                                                                                                                              | Accept                                                                                                                                                                                           | Reject                               | Marks  |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------|
| 6 (a) (i)       | 7                                                                                                                                                                                                                                                   |                                                                                                                                                                                                  |                                      | 1      |
| (ii)            | <b>M1</b> solid<br><b>M2</b> black                                                                                                                                                                                                                  | <u>very</u> dark grey                                                                                                                                                                            |                                      | 1<br>1 |
| (iii)           | <b>M1</b> (formula) – HAt<br><b>M2</b> (name) – hydrogen astatide                                                                                                                                                                                   | AtH<br>astatine hydride                                                                                                                                                                          | hydrogen astatine                    | 1<br>1 |
| (iv)            | <b>M1</b> – (astatine/it/At) is less reactive (than iodine, I)<br><b>IGNORE</b> astatine is unreactive<br><b>M2</b> – elements get less reactive with <u>increasing</u> atomic number/as group is <u>descended</u> /the lower they are in the group | <u>iodine</u> is more reactive<br><br>reverse argument<br>Astatine (atom) has more (electron) shells/outer shell of astatine is further from nucleus so attracts an <u>electron</u> less readily | any references to astatide or iodide | 1<br>1 |
| (b) (i)         | 4 (1) (1) 2 (1)                                                                                                                                                                                                                                     | multiples/halves                                                                                                                                                                                 |                                      | 1      |
| (ii)            | (paper) turns white/bleaches<br><b>IGNORE</b> turns red                                                                                                                                                                                             | (litmus) turns colourless                                                                                                                                                                        |                                      | 1      |
| (c) (i)         | acid<br><b>IGNORE</b> hydrogen ions/names of acids                                                                                                                                                                                                  | correct formula                                                                                                                                                                                  |                                      | 1      |
| (ii)            | to displace (all of) the bromine / to react all of the bromide (ions)                                                                                                                                                                               | bromine (an) <u>ions</u> for bromide<br>to complete the reaction                                                                                                                                 |                                      | 1      |
| (iii)           | $\text{Br}_2 + \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{HBr} + \text{H}_2\text{SO}_4$<br><b>M1</b> all formulae correct<br><b>M2</b> balanced                                                                                           | multiples and halves                                                                                                                                                                             |                                      | 2      |
| (iv)            | $2\text{HBr} + \text{Cl}_2 \rightarrow \text{Br}_2 + 2\text{HCl}$                                                                                                                                                                                   | multiples and halves                                                                                                                                                                             |                                      | 1      |

|     |                                                                            |                                       |                |           |
|-----|----------------------------------------------------------------------------|---------------------------------------|----------------|-----------|
| (d) | <b>M1</b> colourless<br><b>IGNORE</b> clear/transparent/looks like water   |                                       |                | 1         |
|     | <b>M2</b> brown (solution) / (dark) grey/black<br><u>solid/precipitate</u> | red-<br>brown/orange/orange-<br>brown | red on its own | 1         |
|     |                                                                            |                                       | <b>Total</b>   | <b>16</b> |

| Question number | Answer                                                                                                                                                                                                       | Accept                                                                                                 | Reject | Marks       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------|-------------|
| 7 (a)           | <b>M1</b> (reactants) s aq<br><b>M2</b> (products) aq l g                                                                                                                                                    | capital letters                                                                                        |        | 1<br>1      |
| (b) (i)         | to prevent acid escaping/spraying out/spitting out<br><b>IGNORE</b> to prevent water escaping                                                                                                                | solution/liquid/HCl                                                                                    |        | 1           |
| (ii)            | C                                                                                                                                                                                                            |                                                                                                        |        | 1           |
| (c) (i)         | <b>M1</b> A<br><b>M2</b> gas produced/collected more quickly /<br>experiment over<br>in shorter time / (gradient of) line steeper<br><b>M2</b> dep on <b>M1</b>                                              | reaction is faster                                                                                     |        | 1<br>1<br>1 |
| (ii)            | <b>M1</b> 0.1(0)<br><b>M2</b> volume of gas is half/40 ÷ 80 = ½ / 80 = 40<br>x 2<br><b>M2</b> dep on <b>M1</b>                                                                                               | Half the products are<br>produced                                                                      |        | 1           |
| (d) (i)         | <b>M1 &amp; M2</b> - all points plotted to nearest gridline<br>deduct 1 mark<br>for each incorrect plot up to a max. of<br>2                                                                                 |                                                                                                        |        | 2<br>1      |
| (ii)            | <b>M3</b> suitable straight line of best fit (csq on<br>plotted points)<br>(must be drawn with the aid of a ruler). Line<br>need not be extrapolated.<br><b>M1</b> as concentration increases rate increases | (show a ) <u>positive</u> correlation<br><br>as one doubles the other<br>doubles/directly proportional |        | 1<br>1      |

|       |                                                                                                                                                                                                                                                                                                                                                                |             |                                                               |                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------------------------------------------------------|----------------------------|
| (iii) | <p><b>M2</b> proportional / in proportion</p> <p><b>M1</b> more ions/particles (in a given volume)<br/> <b>IGNORE</b> more reactants</p> <p><b>M2</b> collide (successfully)</p> <p><b>M3</b> more per second/more frequently</p> <p>Must be reference to frequency or number of collisions per unit time</p> <p><b>IGNORE</b> greater chance of collision</p> | for 2 marks | <p>molecules/atoms</p> <p>any reference to greater energy</p> | <p>1</p> <p>1</p> <p>1</p> |
|       |                                                                                                                                                                                                                                                                                                                                                                |             | <b>Total</b>                                                  | <b>16</b>                  |

| Question number | Answer                                                                                                  | Accept                                                        | Reject                             | Marks    |
|-----------------|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|------------------------------------|----------|
| 8 (a)           | (i) Impurities/chemicals/substances may affect the colour/flame<br><b>IGNORE</b> affect the result/test |                                                               |                                    | 1        |
|                 | (ii) colour can (easily) be seen (in a non-luminous flame)<br><b>IGNORE</b> references to temperature   | a luminous flame may mask the colour                          |                                    | 1        |
|                 | (iii) yellow/orange/gold(en)                                                                            | any combination of the acceptable colours, e.g. golden-yellow |                                    | 1        |
| (b)             | (i) $\text{Li}^+$ and $\text{Ca}^{2+}$                                                                  | lithium and calcium/Li and Ca                                 | $\text{Ca}^+$ etc                  | 1        |
|                 | (ii) <b>M1</b> – ammonia/ $\text{NH}_3$                                                                 |                                                               |                                    | 1        |
|                 | <b>M2</b> – (water is needed) to form hydroxide ions/ $\text{OH}^-$                                     | to form an alkali/an alkaline solution/ammonium hydroxide     |                                    | 1        |
|                 | (iii) <b>M1</b> – iron(III)/ $\text{Fe}^{3+}$                                                           | to dissolve the ammonia ammonia needs to be aqueous           | any other oxidation states/ferrous | 1        |
|                 | <b>M2</b> – ammonium/ $\text{NH}_4^+$                                                                   | ferric                                                        | ammonia                            | 1        |
|                 | If both names and formulae given both must be correct                                                   |                                                               |                                    |          |
|                 |                                                                                                         |                                                               | <b>Total</b>                       | <b>8</b> |

| Question number | Answer                                                                       | Accept                                                             | Reject       | Marks    |
|-----------------|------------------------------------------------------------------------------|--------------------------------------------------------------------|--------------|----------|
| 9 (a) (i)       | measuring cylinder                                                           |                                                                    |              | 1        |
| (ii)            | <b>M1</b> 44                                                                 | answers in other correct units, e.g. 0.044 dm <sup>3</sup>         |              | 1        |
|                 | <b>M2</b> cm <sup>3</sup>                                                    | ml                                                                 |              | 1        |
| (iii)           | <b>M1</b> $\frac{44 \times 0.01(0)}{1000}$                                   |                                                                    |              | 1        |
|                 | <b>M2</b> 0.00044(0)                                                         |                                                                    | 0.0004       | 1        |
|                 | Mark csq on answer to (a)(ii)                                                | 0.44 for 1 mark only<br>correct answer with no working for 2 marks |              |          |
| (b)             | <u>zinc</u> because                                                          |                                                                    |              |          |
|                 | <b>M1</b> 1 mol zinc reacts with 2 mol HCl                                   |                                                                    |              | 1        |
|                 | <b>M2</b> only 0.005 mol of zinc are needed                                  |                                                                    |              | 1        |
|                 | <b>M1</b> is standalone<br><b>M2</b> is dep on zinc given as being in excess |                                                                    |              |          |
| (c) (i)         | (rate) increases/faster reaction                                             | less time for reaction to take place                               | faster time  | 1        |
| (ii)            | no effect/same volume (of hydrogen) produced                                 | none/no change                                                     |              | 1        |
|                 |                                                                              |                                                                    | <b>Total</b> | <b>9</b> |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Accept                                                                                                                         | Reject | Marks            |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------|------------------|
| 10 (a)          | <p>any two from:</p> <ul style="list-style-type: none"> <li>• forward and backward reactions (still) occurring</li> <li>• concentrations/amounts of reactants/products/components remain constant</li> <li>• rate of forward reaction = rate of reverse reaction</li> </ul> <p><b>IGNORE</b> concentrations/amounts of reactants and products are the same<br/> <b>IGNORE</b> reaction is reversible/goes both ways, OWTTE<br/> <b>IGNORE</b> references to le Chatelier</p>                                          | <p>both reactions (still) occurring</p> <p>stay the same in place of remain constant</p>                                       |        | 2                |
| (b) (i)         | <p><b>M1</b> – (increase in temperature) decrease(s)</p> <p><b>M2</b> – (increase in pressure) increase(s)</p>                                                                                                                                                                                                                                                                                                                                                                                                        | <p>less/<u>lower</u>(s)/drop(s)/gets smaller</p>                                                                               |        | 1                |
| (ii)            | <p><b>M1</b> – (forward) reaction is exothermic/gives out heat</p> <p>OR</p> <p><u>reverse</u> reaction is endothermic/takes in heat</p> <p><b>M2</b> – fewer (gas) molecules/particles on right hand side</p> <p>OR fewer moles (of gas) on right hand side</p> <p><b>IGNORE</b> references to volumes<br/> <b>IGNORE</b> references to le Chatelier's principle<br/> <b>IGNORE</b> references to reverse reaction lowers the temperature<br/> <b>IGNORE</b> references to forward reaction reduces the pressure</p> | <p>more/raise(s)/higher/gets bigger</p> <p>reverse argument shifts to side with fewer (gas) molecules/fewer moles (of gas)</p> | atoms  | 1<br>1<br>1<br>1 |

|              |     |       |                                                                                                                                                  |                                                                                                                                                                                                  |  |                     |
|--------------|-----|-------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------|
| 10           | (c) | (i)   | (the position of) equilibrium is not established/reached                                                                                         |                                                                                                                                                                                                  |  | 1                   |
|              |     | (ii)  | <b>M1</b> – (the mixture of gases is) cooled                                                                                                     | temperature is decreased                                                                                                                                                                         |  | 1                   |
|              |     | (iii) | <b>M2</b> – ammonia liquefies / condenses<br>recycled / <u>re</u> used / recirculated                                                            | put (back) into the reaction chamber<br>used <u>again</u> (in the process)                                                                                                                       |  | 1                   |
|              | (d) |       | <u>heat(ing)</u> / <u>energy</u> costs would be higher                                                                                           | yield (of ammonia) would decrease                                                                                                                                                                |  | 1                   |
|              | (e) | (i)   | <b>M1</b> $M_r(\text{N}_2) = 28$<br><b>M2</b> $112\,000 \div 28 (= 4\,000) / 112\,000 \div \text{M1}$<br><b>M3</b> $8\,000 / \text{M2} \times 2$ | 28 anywhere in the calculation<br><br>$112 \div 28) \times 2 = 8$ for 2 marks<br><br>$(112\,000 \div 14) \times 2 = 16\,000$ for 2 marks<br><br>Correct final answer without working for 3 marks |  | 1<br><br>1<br><br>1 |
|              |     | (ii)  | 1 200 / 15% of <b>M3</b>                                                                                                                         |                                                                                                                                                                                                  |  | 1                   |
| <b>Total</b> |     |       |                                                                                                                                                  |                                                                                                                                                                                                  |  | <b>15</b>           |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                         | Accept                                                                                                                                                                                    | Reject     | Marks               |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------------|
| 11 (a)          | (produces) <u>most</u> heat/energy <u>per gram</u> / <u>per unit mass</u>                                                                                                                                                                                                                                                                      | <u>highest</u> temperature rise <u>per gram</u> / <u>per unit mass</u><br><u>most</u> energy for <u>smallest</u> number of <u>grams</u> / <u>mass</u>                                     | per amount | 1                   |
| (b)             | (produces) <u>most</u> heat/energy <u>per mole</u> / <u>per molecule</u> / <u>per amount</u>                                                                                                                                                                                                                                                   | <u>highest</u> temperature rise <u>per mole</u> / <u>per molecule</u><br><u>most</u> energy for <u>smallest</u> number of <u>moles</u> / <u>molecules</u> / <u>amount</u>                 |            | 1                   |
| (c)             | Any two from:<br><ul style="list-style-type: none"> <li>• heat/energy losses (e.g. by convection, by conduction, to air, to surroundings)</li> <li>• incomplete combustion</li> <li>• evaporation of water</li> <li>• copper / can / beaker / thermometer /apparatus absorbs heat</li> <li>• flame moves around because of draughts</li> </ul> | <ul style="list-style-type: none"> <li>• non-standard conditions</li> </ul>                                                                                                               |            | 2                   |
| (d) (i)         | A                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                           |            | 1                   |
| (ii)            | B                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                           |            | 1                   |
| (e)             | <b>M1</b> breaking bonds is endothermic / takes in heat/energy<br><br><b>M2</b> making bonds is exothermic / gives out heat/energy<br><br><b>M3</b> more heat/energy given out than taken in                                                                                                                                                   | more energy is given out when bonds are made than is taken in when bonds are broken for 3 marks<br><br>more energy is given out when bonds are made than when bonds are broken for 1 mark |            | 1<br><br>1<br><br>1 |

|  |                                                        |  |              |          |
|--|--------------------------------------------------------|--|--------------|----------|
|  | <b>IGNORE</b> references to numbers/strengths of bonds |  |              |          |
|  |                                                        |  | <b>Total</b> | <b>9</b> |



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